GCA Stepper Training Guide & References

General Information about system

The stepper system is used to shoot a repeating pattern over wafer. It is primarily needed for jobs where feature resolution and/or alignment is critical. The contact aligners can be used for many jobs. There is a sign-up sheet on the web for the stepper and you must look at the tool status before signing up for time on this equipment. Please plan your time out as this system can get heavily used.

Also, this system is very expensive and replacement parts, especially the optical column, are also expensive. Please be careful, slow, and meticulous when operating this piece of equipment. Many students rely on this piece of equipment for their research.

1) System: GCA 6300 **5x reduction i-line step and repeat**, $\lambda = 365$ nm
2) Lens system mirrors both X and Y from mask to stepper
3) I-line intensity is ~180 mW/cm^2 at the wafer
4) Lens: Olympus 2142: 21mm field on wafer, NA = 0.42,
   Depth of field = 1.2μm
5) Maximum die size ~(14.8 x14.8)mm2
6) Resolution: 0.7 um reproducible, 0.5 um achievable R&D
7) Registration tolerance: Max 0.30μm global alignment, Max 0.15μm local alignment (with care, you can achieve < 0.10 μm registration)
8) Minimum substrate size: ~ (15 x 15)mm2 (I have seen smaller substrates used in stepper , but they were mounted on a carrier wafer)
9) Maximum substrate size: ~ 4 inch wafer (round) , 6 inch wafer (using custom paddles)
10) The baseline system focus and registration is checked weekly

The system will be down from the following lab conditions:

1) Power Outage. For outages of 1 hour or less, system will be back on line in 2 hours. Four outages more than 1 hour, system will be back on after 8 hours so that mechanical system restabilizes to the environmental chamber.
2) Cooling Water Outage. Environmental unit goes down. For outages of 1 hour or less, system will be back on line in 2 hours. Four outages more than 1 hour, system will be back on after 8 hours so that mechanical system restabilizes to the environmental chamber.
3) Compressed Air Outage. The vibration isolation table will not be operational. System back on line as soon as table legs refill with air.

This document should answer most questions and prepare you for most operations necessary to achieve good results on the stepper. Manuals are available for more detailed descriptions of the stepper operation.

Aligning reticle (mask) to system

The alignment of the mask to the system is critical for achieving reproducible alignment. System alignment marks on the reticle are located near the right and left edges of the mask and are 103 mm apart so they do not get exposed within the 100 mm exposure area of the mask. These marks are put on automatically by Photronix and the gds file can be obtained from Brian Thibeault if you use a different vendor. Use the following procedure to align the mask correctly to the system.

1) Unlock spindle and swing lamp column to middle position so that the lens is exposed.
2) Place mask chrome side down so that wording appears correct (as seen in L-edit file).
3) Swing lamp column so that objective can be used to align mask, DO NOT tighten spindle lock at this time.
4) Using your hands and looking through microscope, shift and rotate mask so that the "crosses" are roughly aligned
5) Tighten spindle lock. This releases a vacuum holder onto the top of the mask so that the mask may be precisely aligned.
6) Looking through microscope, use alignment knobs to translate and rotate the mask into position. First focus the objective by using the knob on top of the microscope. Use the right alignment mark for the x-axis alignment and both alignment marks for the y-axis and rotation alignments. NOTE: to get best and fastest results approach alignment from one direction (do not try to wiggle back and forth about the alignment position. Backlash in the mechanics can make this frustrating). You should see equal amounts of light in between all lines when the mask is aligned well (within 0.1 um).
7) Once mask is aligned, pull the reticle vacuum button to the left of the lens column.

8) Use the stencil (usually L-shape mask cover), to cover part of the mask plate that you do NOT want to be exposed. If you have just one layer on your mask plate, you do not need to use the stensil. There are also blade aperatures that could be used. The knobs on the lamp column X,Y) can be adjusted to 100,75,50 and 25% to be open. Fully open blade aperatures would be at 100%
9) You are now ready to proceed with a focus job, map job, or exposure job.
10) This part is important. If alignments are critical, do not just brush through this procedure. The global alignment requires good, precise alignment of the reticle with the system in order to work correctly. The local alignment system can adjust for local X and Y misalignment, but not rotational errors.

Logging into computer/checking the system

The system administrator will set up a directory for you to log in and use the stepper at the time of training. Before using the system, you will need to log in and perform an interferometer zeroing routine.

1) Check to make sure air table pressure is 60-80 psi.
2) Check to make sure vacuum is >20" Hg
3) At the colon log into the administrator account using LOG IN [10,1]
4) Type MODE and check for proper chuck size and system focus. Use 100 for 4" wafers and use 3 for everything else. DO NOT change any other parameters in here, except the chuck size.
5) Log out using LOG OUT
6) At the colon sign type LOG IN [10,xxx] and hit enter (xxx-your account number)
7) Type ORIG and hit enter. This resets the laser interferometer position measurement system and moves the stages through its entire motion.

Setting up / editing an exposure job (Section 5 of Instruction Manual)

Setting up the job:

This section describes how to set up a job to do a step and repeat exposure of your patterns. A more detailed description is given in section 5 of the instruction manual. Jobs are created using the SPEC command. First information about the array steps, alignment offsets, and general job is asked for. Passes are attached to each job to apply parameters unique to each pass specified. In this way all exposure information for a complete mask set can be specified all in one job. Following is the procedure for setting up a job and passes.
Notes: If at any point you wish to stop and start over with the job description hit CTRL C followed by A and ENTER on the keyboard to abort the SPEC command. An abort of this type will result in no saved information. Also when a * is displayed, this indicates the default value if you hit enter for a reply to a question asked by the computer in setting up or editing any job. If a numeric value is asked for hitting enter will leave the value previously specified, if that

exists. Also, if you put in an incorrect value and wish to go back a step type "?" and ENTER.

1) At the colon sign type SPEC "filename" and hit enter. The filename can be 1 to 9 alphanumeric characters long.
2) Select metric units
3) Input a job comment such as "HBT-1 process"
4) Set tolerance to 1 (default value is 3). Please use 1-the time required to stop and settle the stage to tolerable degree of vibration.
5) Scale corrections will only be needed if wafer shrinkage or expansion has occurred in a previous process step. Hitting enter without entering a value here results in 0 being used. This is the normal answer.
6) Hit enter for orthogonality with no value.
7) Enter the wafer diameter in mm. This defines the maximum area in which exposure can occur. If you have a square or non circular piece, you will need to specify a diameter that includes the entire square, not the length of a square.
8) Enter the step size in X in mm at the wafer plane
9) Use "C" for specifying the number of columns to expose, "S" for spanning a certain width in the X direction, and A to fill in all area in X direction to the edge of a circular wafer. For square pieces you will always use "C". For full wafers, you may use any of these options depending on the process. For quarter wafers, you will most likely use "C" and make the job array look square. You will then use dropouts in each pass to specify more complicated array shapes.
10) When "C" is entered, you will then be able to enter the number of columns desired.
11) Repeat 8 through 10 for the Y step. The final array is centered on the wafer.
12) Translate Origin is generally used only if the wafer is off-center.
13) If you wish to see an "*" cartoon of the exposure array hit Y for display, otherwise hit Enter.
14) Layout will give you a display of the nuber of rows and columns and the distance from die 1,1 to the array center, taking origin translation into account.. Ususaly this is not looked at. Hit enter to pass this up.
15) If you wish to adjust the numbers of rows and columns you can do this at the Adjust prompt. Usually, you can hit enter to skip this.
16) Standard Keys. If this is used, then the die used for right and left alignment is chosen automatically by the system. This is good if you have a wafer larger than 38.1 mm in the X direction and both alignment marks are exactly 38.1 mm apart and have the same offset from the die center. If you do not meet these conditions, you will need to choose N.
17) If "N" is chosen you will need to enter the row and column of the alignment die.

18) Right Key Offset. The distance from the die(mask) center to the alignment mark center for the alignment mark die. Enter the number in mm at the wafer plane. See picture below for sign convention of alignment key offsets.

Sign for Alignment Key On Mask

CL

- X
+Y

CL
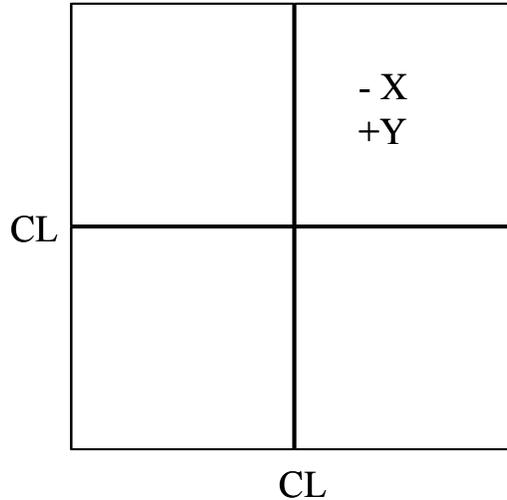
19) If non-standard alignment keys are selected, you will need the Left Key Offset as well.
20) Skip through epi shift.
21) Now you are ready to enter information specific to passes.
22) Enter the name of the first pass. When you expose a job, you will specify it as filename\pass. The name of a pass can be 1 to 9 alphanumeric characters long. (i.e. emitter)
23) Next enter a pass comment
24) Next, input an exposure time between 0 and 128 sec. The calibrations are done at 1.2 sec. Since the lamp power is held constant, your times should not change over time. This time should be optimized for your substrate and process before doing the real devices to ensure optimum resolution.
25) Based on a focus calibration that you do, you will have a focus offset from the baseling calibration job. The current baseline focus setting is posted on the machine, so you should enter the correct focus setting for your job based on the current calibration.
26) Enter Y or N for local alignment
27) Select G for the Revert to command, the P option does not work.
28) Enter 1 for number of sites per DXD alignment if you will be using the local alignment, this will align every die.
29) For Die Alignment Offset, the offset of the DFAS center to the die center at the wafer plane is entered for X and Y. You should run a test sample to determine how well the DFAS system is performing for your mask set and process. You may need a small offset in X or Y to compensate.
30) Use pass shift to shift all exposures in this pass by a set amount. Usually this option is passed over, but may be used if you have multiple levels on a single

mask and are aperturing all layers but the one of interest and this pattern is off-center. You would enter the correct offset to ensure pattern alignment. See picture below for sign convention for X and Y for pass shifts to place pattern into center of wafer.

Sign for Pass Shift On Mask

```
            ┌───────────┬───────────┐
            │           │           │
            │           │   +X      │
            │           │   - Y     │
            │           │           │
         CL ├───────────┼───────────┤
            │           │           │
            │           │           │
            │           │           │
            │           │           │
            └───────────┴───────────┘
                   CL
```
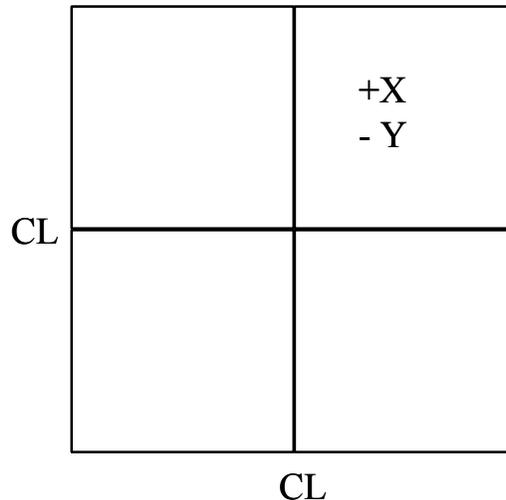
31) Array or Plug. When P is entered, only those row and column sites that the user enters will be exposed. When A is entered all sites previously specified will be exposed except dropouts specified later.
32) When P is entered, enter the row and column numbers of die you wish to be exposed. Enter D at the R prompt to display the currently selected die. Press return with a blank entry at the R prompt when finished.
33) In the dropouts section, sites or entire rows or columns can be removed from the exposure. Enter the row. Then enter at the C prompt : nothing to remove the whole row, the first and last column number with a dash in between (i.e.3-6) to remove several sits, or a single number to remove a single site. Enter D at the R prompt to view the die that will be exposed. Enter V at the R prompt to see a list of dropouts. Enter ? at the R prompt to put back in the last die that was dropped out. Again hit return with no entry at the R prompt to exit.
34) Answer Y to save pass.
35) If no other passes are desired, hit enter with no entry at the name prompt.
36) Enter another pass name if desired and hit enter.
37) If the pass information is mostly the same as a previous pass, hit Y at the Copy prompt and enter the name of the pass to be copied, then change any needed parameters after the job is saved using the EDIT command.
38) Say Y to Write to Disk or all information will be lost.
39) You are ready.

Editing an existing job:

To edit an existing job, use the EDIT command followed by the file name. You can then scroll through job and all passes and change any desired parameters. Don't forget to save the changes. If you just wanted to look at the program you can use the EDIT command and then use CTRL C followed by A and a carriage return to abort the command and not save any changes.

Loading a wafer into the system

Before loading a wafer, after putting on the resist, make sure that there is no resist on the backside of the wafer. This can cause errors in the interpreted best focus point since the wafer surface may be at a different height.

1) Attach the appropriate chuck to the system.
2) Place your wafer centered on the chuck, noting the orientation. If you are doing an alignment step, make sure to place the wafer in the same orientation and as best as possible in the same location as the first exposure. The set screws in the chuck can help to get reproducible placement of the wafer. When the wafer is in place, flip the right vacuum switch upwards to hold the sample.
3) Place the sample chuck onto the stage, again trying to be repeatable, and flip the left vacuum switch upwards to hold the chuck.
4) Now you are ready to do an exposure.

Focus / Exposure optimization (End of Section 5 of Instruction Manual)

The system is calibrated weekly on 2 inch Si wafers with the 2" wafer chuck. Your substrate type/thickness/resist may require different focus and exposure settings that the standard calibration. A focus / exposure optimization should be done to tweak your process relative to the calibration baseline. To do this you can use one of your already defined jobs and passes and your highest resolution mask. The command EXPO will shoot a specified serpentine array based on the parameters in your job\pass. The focus and/or exposure can be varied across this array to determine the optimum focus relative to the baseline. One focus step is equal to 0.1 um of focus depth.

1) Before doing an expo job, use the "MODE" command to check that the system focus is set as recorded in the baseline sheet attached to the machine. **Do not change any other values using this command**.
2) Use the command EXPO jobname\passname and hit enter
3) Enter starting row within array specified in the pass
4) Enter ending row within the array specified in the pass
5) Enter starting column within array specified in the pass
6) Enter ending column within the array specified in the pass

7) Enter F to vary the focus in a serpentine pattern, E to vary the exposure in a serpentine pattern, or R to increment focus for each row and exposure for each column within the array.
8) Enter the parameters as prompted by the computer. They will differ based on which option is chosen.
9) Press RESET on the small keyboard next to the monitor
10) Press the MAN and S/C simultaneously
11) Wait a few seconds and press MAN again and the wafer will move underneath the two objectives used for global alignment.
12) Since alignment is not needed for a calibration like this, press the EXP key on the small keyboard to shoot the array. The PC next to the stapper will display a cartoon showing each die as it is exposed.
13) When done, do the development according to the process and inspect in the microscope.
14) The computer will ask you for the best row and column.
15) The computer will then tell you the focus and exposure based on the row and column you input.
16) **Do not update system focus !** Input a focus offset into your own exposure job. (If you update the focus, you must change it back using the MODE command when you are done)

Performing an exposure job

1) Before doing an expo job, use the "MODE" command to check that the system focus is set as recorded in the baseline sheet attached to the machine. **Do not change any other values using this command**.
2) Type EXEC jobname\passname and hit enter. (See "*Wafer alignment to mask / Local Alignment (DFAS)*" below for local alignment job syntax)
3) Type in the desired exposure time.
4) Type in desired focus offset.
5) Press RESET on the small keyboard.
6) Press MAN and S/C simultaneously.
7) Wait about 5-10 seconds.
8) Press MAN.
9) Sample will move to alignment position/do global alignment.

Wafer alignment to mask / Local Alignment (DFAS) :
The best way to use this is to use a mapping routine followed by a shoot using the corrections given by the map. A mapping routine should be set-up in your job with a pass name named mapxx. Make sure you specify die x die is to be used and that you have the correct key offsets for the global and local alignment marks. The command you will then use is: MAP jobname\mapxx,jobname\passname. The first exposure is the mapping pass. When asked to make corrections, say yes. The exposure job will then be performed.

Wafer alignment to system / Global (Manual Operation Only)

The joysticks and focus knobs are used in this part of the exposure sequence to align the wafer to the system. The sequence of operations you do will depend on whether or not you used standard alignment keys or not. If you placed the sample close to the position you did during the first exposure, you should see an alignment mark in the right side of the screen. If not, you will need to find this mark using the position joystick by following a spiraling outward from the initial position. Pressing "F" repeatedly on the keyboard will do this spiral finding for you automatically. The joysticks have a double speed. Press joystick far for the high speed, shallow for the low speed. To change the joystick speed hit O on the main keyboard. Once the alignment mark is found follow one of the following procedures.

Standard Alignment Keys:
    a) Adjust the focus knob to get a crisp image.
    b) Align the right mark using the position joystick.
    c) Use the Theta joystick to rotate the left image into position. Positive Theta = clockwise rotation of chuck. If you run out of theta alignment, you will need to adjust your sample on the chuck.
    d) The left image is used for theta only.
    e) Repeat process until satisfied with the alignment. You can obtain better than 0.2 um alignment consistently if you are careful with reticle and global alignment.

Non-Standard Alignment Keys:
    a) Adjust the focus knob to get a crisp image.
    b) Align the right mark using the position joystick.
    c) Press A on the main keyboard to toggle to the left alignment mark.
    d) Use the Theta joystick to rotate the left image into position. Positive Theta = clockwise rotation of chuck. If you run out of theta alignment, you will need to adjust your sample on the chuck.
    e) The left image is used for theta only.
    f) Press A again to move to the right alignment mark
    g) Again adjust the right alignment mark
    h) Repeat process until position and theta are acceptable.

9) After global alignment, press EXP on small keyboard and the job will be executed.
10) Remove the sample from the stage when done.
11) Develop resist and inspect in microscope for alignment (if needed)
12) Computer may ask for next wafer. To escape out of this press CTRL C followed by A and the enter key to abort out of the loop. If you have another wafer with the same job\pass, you can do it now without aborting.

Logging out of computer when done/End of job

1) Use LOG OUT command.
2) Log back into the [10,1] account using LOG IN [10,1]
3) Type MODE and change the chuck size back to 3 and the focus back to the calibrated value
4) Use LOG OUT to leave the system
5) Remove your mask and make sure the lamp source is covering the lens.
6) Make sure the doors to the environmental chamber are closed.

User Accessible Commands – Definitions

COPY – Use this to copy a file from someone else's directory to your own. You will need to know the user log in drive and the filename
DELETE – Removes a file from system
DISP – Display the parameters for a job
EDIT – Use to edit exposure jobs and passes
EXEC – Use this to execute an exposure job
EXPO – Use this to perform a focus and/or exposure calibration
HELP – Use this to find out the syntax and use of any command.
LISTF – Lists a directory of files
LOAD – moves the stage to the load position, may be needed if the stage/computer hangs up.
LOG IN [10,xxx] – To log into computer
LOG OUT – To log out of system.
MODE – You can use this to change the chuck size (from the [10,1] account only) and verify the focus of the system. **Do not change any other parameters or you will throw the system out of calibration**.
ORIG – Use this to retune the originate the laser counter / move the stages through their entire motion.
PURGE – Delete files from directory
RENAME – Rename a file
SPEC – Create a job file, must go all the way through to save the job.

Useful Control Characters
CTRL C followed by A and Enter – Abort back to colon prompt
A – Toggles between left and right alignment die when using non-standard keys
D – Sets joystick to move from die to die.
T – Sets joystick to move left alignment die under right objective.
E – Exit out of D or T mode so that joystick is back to normal.
O – Vary joystick speed during alignment.
F – Each time you press this, it will move the stage about an increasing spiral path away from the initial location. Use this repeatedly to find the alignment marks for samples placed differently on chuck than in initial exposure.
CTRL S – stops monitor scrolling function
CTRL Q – resumes monitor scrolling function

System Shut-down procedure.

1) Pull out keyboard for ICS/Advent computer (upper keyboard)
2) Hit scroll twice (you will hear a faint beep). Immediately press "2"
3) Push ICS/Advent keyboard back in.
4) Lift up plastic piece over stepper keyboard (lower keyboard)and press break.
5) Pull out monitor to expose monitor power switch on top right of system.(if it does not want to come out, the shield is hitting the frame, use a long screwdriver to help get it out)
6) Turn off monitor power
7) Turn off all other rack components. Do not turn off lamp.
8) Open top folding door on rack and turn off the computer interface.
9) Turn off lamp power.
10) Pull back out ICS/Advent keyboard (upper keyboard)
11) Exit the program running on the PC ("Alt F" for file followed by "x" for exit)
12) Turn off power to the top black advent computer on the rack
13) Turn off power to the bottom black advent computer on the rack
14) Turn off little pump in back of system.
15) If cooling water is to go out or has failed, turn off the environmental unit with the large red breaker at the top left of machine.
16) Turn off system power switch (Switch located on monitor box and is labeled)

System Start-up procedure.

1) Turn on system power switch (Switch located on monitor box and is labeled)
2) Turn on environmental unit with large red breaker.
3) Turn on little pump in back of system
4) Turn off lamp fan in circuit breaker panel
5) Turn on lamp power and start lamp.
6) Once lamp reaches 200W, turn on fan in breaker box (**THIS IS IMPORTANT**)
7) Open top folding door on rack and turn on the computer interface.
8) Turn off all other rack components.
9) Turn on monitor power
10) Let monitor warm up until you see a cursor on the screen.
11) Hit the Set Up key on the stepper keyboard (lower keyboard)
12) Hit Line/Local key so that the on-line LED lights.
13) Hit the Set Up key again. You should have a cursor on the screen
14) Turn on upper advent computer
15) Turn on lower advent computer
16) Pull out upper keyboard and look at upper screen
17) Type "stepper" at the command prompt
18) Type "Alt O" followed by "S". Upper screen should go blank and stepper screen should begin to show commands.
19) Push in upper keyboard.
20) Enter date and time on lower keyboard when asked by stepper

21) Stepper will finish booting up.
22) Pull out upper keyboard and hit "Scroll" twice. You will hear a beep, then hit "1". This will change the monitor control over to the bottom Advent computer and you will see the "Waiting for MOP command" line at bottom.
23) In the environment al chamber, on the right side, is the interferometer laser power supply. There is a bank of green LEDs there that will tell you when the laser is ready. Make sure the "ready" light is lit and not flashing before you begin.

Troubleshooting.

What to do in case of computer (monitor) freeze-up. Please try these things in this order.

1) Try CTRL C followed by A and Enter. This will abort any command that may have hung up.
2) Press RESET on small monitor keyboard.
3) Follow this sequence:
   a) Pull out upper keyboard.
   b) Hit "Scroll Lock" button twice followed by the number 2. This switches the upper monitor from the smart-set computer to the PC control computer. Try a second time if this doesn't work. You should see a black screen with "Ready" near the top or you will see a menu driven screen. If the monitor switching does not work, go up to the gray interfce box on top of the stepper control rack. Press the gray flash button. This is located in the area where the cables all plug in.
   c) Push in upper keyboard.
   d) Lift up plastic flap over lower keyboard and press break
   e) Turn off lower monitor by pulling out the monitor box and using the switch on the top right front corner of the box (DO NOT TURN OFF SYSTEM POWER SWITCH ON MONITOR! This will shut down the whole system)
   f) Wait 1 minute and turn the monitor back on.
   g) Let monitor warm up until you see a cursor on the screen.
   h) Hit the Set Up key on the stepper keyboard (lower keyboard)
   i) Hit Line/Local key (number 4) so that the on-line LED lights.
   j) Hit the Set Up key again. You should have a cursor on the screen.
   k) Pull out upper keyboard and press the Alt button and "O" at the same time.
   l) Hit Return to start the program.
   m) Push in upper keyboard.
   n) At the prompt on the lower monitor, enter the time and date as specified (10:25 19-NOV-02)
   o) Stepper will finish booting up.
   p) Pull out upper keyboard and hit "Scroll Lock" button twice followed by the number 1 to transfer monitor back to the smart-set computer. Try a couple times if this does not work and use the flash button (see instruction b) if needed.
   q) You are ready to Log In.

4) Follow this sequence:
   a) Follow system shut down sequence, but DO NOT TURN OFF LAMP OR ENVIRONMENTAL UNIT
   b) Wait 5 minutes.
   c) Follow system start-up sequence except for instructions on lamp or environmental unit.

What to do if the local alignment or wafer exposure mapping hangs up on the upper monitor.
   1) Reset lower Advent computer and wait for reboot.

What to do in case of unplanned power outage.
   1) CR Staff will take care of the system in the morning.

What to do for alignment error.

   1) Verify that correct alignment key offset is being used
   2) Verify that the mask is aligned
   3) Verify that the baseline is correct (check values in MODE against the last calibration in the calibration notebook)
   4) If you have DFAS alignment marks, perform a MAP job to verify alignment.

What to do for focus resolution problems.

   1) Verify system focus using the MODE command
   2) Perform a focus (EXPO) job using the same type of wafer that you will use for your real job and use the optimal focus offset determined from this job. You may need to look at both exposure time and focus.
   3) Verify that your wafer is not bowed (i.e. under stress from some process)

What to do in case of mask vacuum problem.

   1) Check that small pump is running in back of system.
      Make sure vacuum level is above 20" Hg.
   2) Push foot down onto mask with hand so that the vacuum holds the mask.

What to do in case of focus getting stuck and system hanging up.

   1) Adjust manual focus knob so that a negative number appears on volt meter.
   2) Note die on computer screen at right of system. Abort using Ctrl-C followed by A, edit the program and drop out the problem die. If you have exposed some die already, you may want to drop them out too for the second run.

What to do in case of the stage limit going too far (red stage limit light will be lit inside the stepper chamber next to the joystick.

1) Press the lit limit switch to release the stage.

Contacts to call if you cannot undo the problem. Do not call after 10 p.m. unless there is a real emergency (A deadline for a paper or conference is not a real emergency)

1) Brian Thibeault : x 2268 Work or 964-4009 Home
2) RTS Inc. (These guys know all about the stepper, they rebuilt it and service it under contract for us). Ask for Matt or Robert. 480-892-4433.
3) If neither can be reached, leave a note on the stepper and the white board that the stepper is down. E-mail Brian Thibeault at thibeault@ece.ucsb.edu to report the problem.

Mask Layout / Alignment Marks / Ordering from Photronics / Specifications

5) Mask specifications to Photronics using old Connexant order form
    The following material should be sent to them to do a job:

2. Mask file in GDSII format by ftp. Site: "dragon.photronics.com or 207.77.140.1", User Name: ucsbsd@199.36.4.16 Password: university.
3. The mask file should be the same scale size as will appear on the mask. The features on the wafer will be 5 x smaller. L-Edit has a feature to scale dimensions so that the original mask file can be made with the correct on-wafer dimensions and then the job can be scaled and saved as a separate file. Each layer in the document must have a unique GDSII number assigned to it. These numbers are used by Photrinics.
4. You must send a purchase order and put a part number on the order form. The part number is anything you make up and will appear on the mask.
5. You need to fill out a Connexant Photomask Order form (2 pages). Most fields you will fill in are obvious. Here are the meanings of the not-so-obvious ones.
    Media Type : "ftp" is the answer for electronically sent data.
    Data Scale : "1 x" is the correct answer if the mask layout dimensions sent are those that will be on the mask (remember that the system will shrink these dimensions by 5 times on the wafer)
    Material : Quartz
    Material Size: 5" x 5" x .09"
    C.D. Feature Type: "rectangle" is usually the correct answer
    Data Extents Xlow, Ylow, Xhigh, and Yhigh: In the L-edit mask file, these are the box coordinates, in microns from the origin, of a box that just contains all of the features in the mask.
    Reticle/Mask Level I.D: The name of the level
    Topcell Structure Name: The cell in the L-edit file that contains the features data for the mask.

Add. Unit: This is the address unit size of the beam used by Connexant to shoot the mask. This will affect the price.

Chrome Side Down Reading: "Right" is usually correct. This specifies that if the Chrome is facing down, all features will appear as in the mask file. Also that the text will be readable.

Polarity: "Clear" for a positive pattern (i.e. objects will be in chrome and block light) "Dark" for the opposite polarity.

CD: Size of critical dimension in microns

Overlay Registration to grid: See price list. This sets the guaranteed precision of one mask level feature relative to another.

Pellicle Req'd: "No" is the correct answer.

Connexant PRMIS Lot No: Leave blank.

Special Instructions: "Use tucsbgca.jb alignment marks for masks", "See attached drawings for CD placement and specifications for each layer and for text information to include at the outside of each mask"

6. The location of the critical dimension (CD) features, what they look like, and what the dimensions are should be included for each layer in which CDs are important.

7. Also include any text that you want to be written at the outside of the usable mask area for each layer for your own purposes. For example, the mask name, layer name, Key Offset for Global Alignment in X and Y (i.e. One could ask for the text KOGX 25um to specify a key offset in X of 25um for global alignment, etc.), the key offset for local alignment in X and Y, and the repeat step distance in X and Y would be good to include on each layer.

6) Alignment marks in exposure field, Global, Local (DFAS). To learn more about how these alignment marks work with the system, see the reticle handbook. In our system we mainly use manual global alignment to get +/- 0.25 or better alignment tolerance. Local alignment can be used but needs some characterization for each process.

Global alignment marks: These marks and how to place them on the mask are described on page 5-44 to 5-47 of the reticle handbook and are included as an attachment to this document. The difference of our system from the manual is that the objectives are 38.1 mm apart, not 76.2 mm as indicated in the manual. The distance of this mark (or marks) to the center of the cell in X and Y should be noted, this is the key offset and will be required when exposing a job. (Positive offset values are left for X and up for Y)

Local alignment marks: These marks and how to place them on the mask are described on page 5-33 to 5-34 of the reticle handbook and are included as an attachment to this document. If possible use one of each type if you desire to try to use local alignment. These can be light or dark field in nature. The distance of the center point of this mark (or marks) to the center of the cell in

X and Y should be noted, this is the key offset and will be required when exposing a job.

7) *Vernier Scales:* These can be included to quantify the alignment offset after an exposure is done. The reticle handbook has an example of vernier scales on pages 5-49 to 5-53. You should include them for any layers that require critical alignment.

8) *Resolution:* If you have room in the mask layout, it is good to have features that can give the resolution of a given exposure. The resolution should show both "pillars" and "trenches" in the resist so that you can see whether the focus or exposure needs some tweaking for your particular process.